

# Laboratory-Scale Physical Modeling of Dense Chlorinated Solvents in the Subsurface

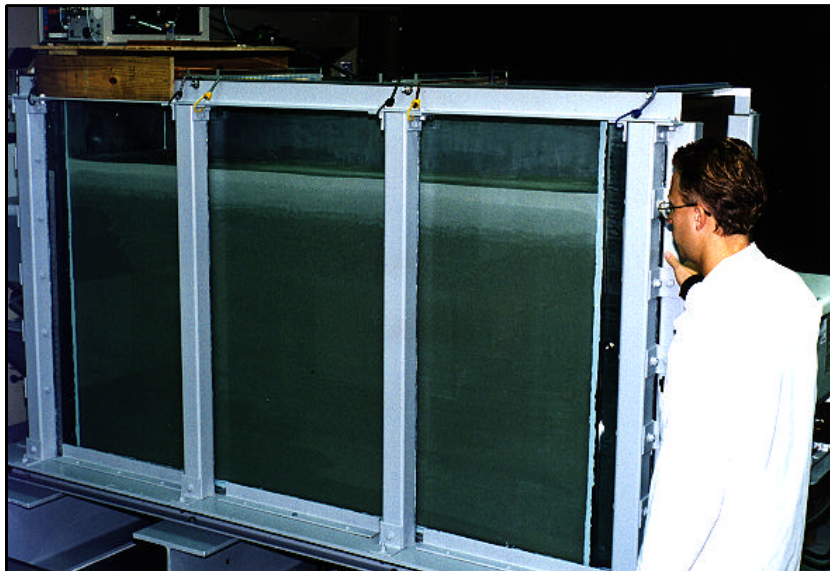
A Research Effort of the US Air Force Research Laboratory (AFRL/MLQ) and Academia

## THE PROBLEM

Many subsurface sites on Air Force installations are contaminated by dense non-aqueous-phase liquid (DNAPL) chlorinated solvents such as trichloroethylene (TCE) and tetrachloroethylene (PCE). Once released into the subsurface, these liquids can become long-term sources of groundwater contamination due to their low water solubility. Small spills can result in large plumes of groundwater unsuitable for human consumption. Drinking water standards for chlorinated solvents are commonly in the ppb range. Methods for locating and remediating subsurface DNAPL contamination zones require an understanding of the physical and chemical processes governing their behavior.

## THE GOAL

An experimental study investigated DNAPL behavior in the subsurface. A large-flow container was constructed to simulate an unconfined aquifer, specifically designed for use with chlorinated solvents. All materials are non-sorptive; the system is completely enclosed, allowing mass balance on volatile components. This unique system allows measurement of three-dimensional concentration distributions of aqueous- and non-aqueous-phase liquids, and vapor concentrations in situ, under dynamic flow conditions. The system was used to investigate the effects of three-dimensional groundwater velocity and flow-bypass on the dissolution behavior of a mixed DNAPL residual (TCE and PCE). New methods for locating residual DNAPL zones by using reactive tracers were studied in this system.



Front Physical Modeling System

## BENEFITS OF LABORATORY-SCALE PHYSICAL MODELING

Laboratory-scale physical modeling provides a unique means for investigating the subsurface behavior of DNAPLs. In particular, laboratory-scale physical modeling offers a high degree of control over the variables (e.g., groundwater velocity and chemistry, soil microbiology) affecting subsurface DNAPL distribution and fate. Shorter timeframes allow performance of many experiments, under a variety of conditions. Also, aquifer medium characteristics can be changed, and chemicals, which normally could not be used in a field investigation, can be used in a physical model.



Back of Physical Modeling System

## THE PAYOFF

This study produced a more complete understanding of the fundamental processes controlling the transport and fate of DNAPLs in the subsurface. The knowledge gained from this research can be directly applied to the development of new strategies for locating and remediating subsurface DNAPL contamination.

## POINTS OF CONTACT

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